Ballast - General Information

BALLASTS

Ballasts are electrical control devices that provide discharge lamps with high starting voltages and then limit the operating current. All fluorescent and HID lamps required a ballast in order to operate. Ballasts themselves consume electricity, so efficient ballast design can increase the efficiency of the lamp-ballast system by decreasing the ballast losses. Specific ballasts are used for different types of lamps. For instance, ballasts used in fluorescent fixtures include preheat, instant start, and rapid start varieties. Preheat ballasts use a starter to preheat the lamp filaments before the ballasts provide the starting voltage that arcs across the lamp. These ballasts also remove power from the filaments during operation. Instant start ballasts do not require filament power and need a very high initial voltage to start the lamp. Rapid start ballasts continuously heat the filaments while the lamp is started and operated. Neither instant start nor rapid start ballasts require a separate starter.

ELECTROMAGNETIC BALLAST:

Because ballasts are vital to fluorescent lamp operation, they've been available as long as the lamps they start and regulate. Throughout most of their history, fluorescent ballasts have been of the electromagnetic type. As a result of their design, these "old standbys" are also called "core & coil" or electromagnetic ballasts. The electromagnetic ballast consists basically of a core of steel laminations surrounded by two copper or aluminum coils. This assembly transforms electrical power into a form appropriate to start and regulate the fluorescent lamp. The third major component of most electromagnetic ballasts is the capacitor. The capacitor of an electromagnetic ballast improves its power factor, so it can utilize energy more efficiently and an electromagnetic ballast that is equipped with a capacitor is considered a high power factor ballast. Today's latest generation of electromagnetic ballasts incorporates a "high efficiency" design. Because their design minimizes ballast losses, they provide energy savings as well as longer ballast life, lower maintenance costs and cooler operation. Ballast losses in electromagnetic ballasts may be reduced by upgrading ballast design and material, as was done with the energy-efficient energy saver ballast. Another method of producing light at reduced power requirements entails adding a device to cut off the power used to heat lamp electrodes once the lamps are started. Most energy saving ballast use this cutoff to limit power consumption. To achieve satisfactory operating results, electromagnetic ballasts must be designed with the proper number of core laminations and coil windings to operate lamps of a specific size and type. Therefore, electromagnetic ballasts will not operate lamps other than those for which they are designed. The electromagnetic ballast remains a vital and useful mainstay of the lighting industry, but its single-use restriction limits its flexibility.

ELECTRONIC BALLASTS:

The electronics revolution has resulted in dramatic improvements in ballast performance. The electronic ballast, based on an entirely different technology than the electromagnetic ballast, starts and regulates fluorescent lamps with electronic components rather than the traditional Core & Coil assembly.

Operating Frequency:
Present day electromagnetic ballasts operate at a voltage frequency of 60 Hertz (Hz)-60 cycles per second, which is the standard alternating current frequency provided in the United States. All electronic ballasts, on the other hand, convert this 60 Hz input to operate at frequencies of between 20 and 60 Kilo-Hertz (KHZ), 20,000-60,000 cycles per second, depending on the specific model. The operating frequency of a ballast is often illustrated as a sine curve. The differences in the operating frequencies of both electromagnetic and electronic ballasts are immediately apparent in a comparative graph.

Greater Energy Efficiency:
Because electronic ballasts function at high frequency, the fluorescent lighting systems they operate can convert power to light more efficiently than systems run by standard electromagnetic ballasts. For example, electronic ballasts can produce about 10 percent more light from standard fluorescent lamps using the same power as electromagnetic ballasts. However, the lighting industry considers the amount of light already produced by today's electromagnetic ballast-driven lighting systems to be consistent with generally accepted lighting levels. So, all electronic ballasts are designed to produce the same amount of light from standard fluorescent lamps as conventional electromagnetic ballasts but using significantly less power thereby cutting energy costs. For example, an electronic ballast operating two, four-foot energy-saving rapid start lamps requires input power of 60 watts to deliver the equivalent light output of a standard electromagnetic ballast that requires input power of 82 watts. This represents a 27 percent energy savings.

Ballast Hum:
All electronic ballasts are ideal for use in extremely quiet environments because steel laminations have been eliminated from their design. The amount of sound emitted by a ballast is measured in decibels (dB). All sounds above 0 dB are audible to some extent. Most electronic ballast operates at levels approximately 6 decibels less than electromagnetic ballasts. As a rule, for every 3 dB reduction in sound, ballast noise is cut in half.

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The Weight Advantage:

Electronic ballasts are light in weight compared to electromagnetic ballasts, with some weighing less than half as much. There are two reasons for this:

- Electronic components are lighter than the metal components of the Core & Coil assembly.
- Electronic components are conformably coated with protective resin, while the entire case of the electromagnetic ballast is filled with resin. The resin protects ballast components from moisture and provides a sound barrier. Benefits of a lighter weight ballast include lower shipping costs, easier handling in installation and lower structural stress on ceiling supports (minimizing the need to rework suspended ceilings after the installation of new lighting fixtures). Electronic ballast make a significant difference in total fixture weight. For example, in a 4-lamp fixture, two electromagnetic ballasts would weigh a total of 7.4 lbs. compared to their electronic equivalents at a total of 3 lbs.

Cooler Operation:

For each 10 degrees C cooler an electromagnetic ballast operates, its life is doubled. Although life-test research has not yet been completed on the effect of cooler operation on electronic ballast life, the life of solid-state ballasts is definitely extended by cooler operation. Most electronic ballasts operate a full 30 C cooler than the standard electromagnetic ballasts and 12 C cooler than energy saving electromagnetic ballasts. The cooler operating characteristics of the electronic ballast offer another advantage, savings in air conditioning costs. Over-all energy costs for an installation where electronic ballasts are used are less because these ballasts operate cooler and reduce air conditioning requirements.

Dimming :

Unlike incandescent lamps, fluorescent lamps cannot be properly dimmed with a simple wallbox device such as those used for incandescent lamps. For a fluorescent lamp to be dimmed over a full range without a reduction in lamp life, its electrode heater voltages must be maintained while the lamp arc current is reduced. As such, lamps operated in rapid start mode are the only fluorescent lamps suitable for wide-range dimming applications. The power required to keep electrode voltage constant over all dimming conditions means that dimming ballasts will be less efficient when operating lamps at dimmed levels.

Dimming ballasts are available in both magnetic and electronic versions, but there are distinct advantages to using electronic dimming ballasts. To dim lamps, magnetic dimming ballasts require control gear containing expensive high power switching devices that condition the input power delivered to the ballasts. This is economically viable only when controlling large numbers of ballasts on the same branch circuit. In addition, luminaires must be controlled in large zones that are determined by the layoutof the electrical distribution system. Since the distribution system is fixed early in the design process, control systems using magnetic dimming ballasts are inflexible and are unable to accommodate changes in usage patterns. Dimming of electronically-ballasted lamps, on the other hand, is accomplished within the ballast itself. Electronic ballasts alter the output power to the lamps by a low-voltage signal into the output circuit. High power switching devices to condition the input power is not required. This allows control of one or more ballasts independent of the electrical distribution system. With dimming electronic ballast systems, a low voltage control network can be used to group ballasts together into arbitrarily-sized control zones. This control network may be added during a building renovation or even, in some circumstances, during a lighting retrofit. Low voltage wiring does not have to be run in conduit, which helps keep installation costs down. In addition, it is less costly to modify the size and extent of lighting zones by reconfiguring low voltage wiring when usage patterns change. Low voltage wiring is also compatible with photocells, occupant sensors, and energy management system (EMS) inputs

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Dimming electronic ballasts permit the light output of the lamp to be continuously controlled over a range of approximately 10% to 100% of full light output. A low voltage signal (usually between 0 and 10 volts) to the ballast output circuit modifies the current to the lamp. Dimming electronic ballasts are equipped with feedback circuits that maintain electrode voltage when the lamp current is reduced. This allows the lamp to be dimmed over a wide range without reducing lamp life. This dimming technique contrasts with that of magnetic ballasts in which input power to the ballast is modified to alter the lamp current, which also reduces electrode voltage. This limits the practical dimming range of lamp to about 50% of full light output.

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BALLAST PERFORMANCE FACTORS:
Ballast performance factors help provide a comparative measurement of ballast operating efficiency-both in efficiency of power use and relative ability to produce light.

Power Factor:
The Power Factor of a Ballast is the measurement of how effectively it converts the voltage and current supplied by the power source into watts of usable power delivered to the ballast. Perfect power utilization would result in a power of 100 percent. As a rule, ballast power factors may be classified under any one of the following three categories:

High Power Factor	90% or greater
Power Factor Corrected	80 to 89%
Normal (Low) Power Factor	79% or less

Power Factor measurements pertain only to the effective use of the power that is supplied to the ballast; they are not an indication of the ballast's ability to supply light through the lamps. Thus, the power factor supplied by the ballast manufacturer should never be used as a multiplier (lamps lumens x power factor) in determining actual light output (lumen) values.

Because high power factor ballasts are more efficient than low power factor units, they are specified for all commercial lighting applications. Lower power factor equipment requires higher line currents and can load the branch circuits, as well as those of the utility supplying the power (sometimes resulting in penalty charges). Low power factor ballasts require about twice the current needed by high power factor ballasts, allowing fewer fixtures per circuit and creating added wiring costs.

Ballast Factor:
The Ballast Factor is the measurement of the ability to produce light (lumens) from fluorescent lamps. It is the ratio of light output produced by the lamps operating on a commercial ballast versus the light output produced by the same lamps when operating on a standard laboratory reference ballast.A ballast may have different ballast factors for different lamps. That is, it may have one ballast factor for operating standard lamps and another for operating energy saving lamps. For example, a Certified Ballast Manufacturers (CBM Approved) ballast must be designed to operatestandard 40 watt rapid start lamps while maintaining a minimum ballast factor of .925. However, when these same ballasts operate energy saving lamps,their ballast factors average .88.

Ballast Efficacy Factor:
The Ballast Efficacy Factor is a ratio of the light output produced by the ballast to the watts input to the ballast. This measurement is generally used to compare the efficiencies of various lighting systems. Because the ballast factor is an indication of the amount of light produced by the ballast/lamp combination and the input watts an indication of power consumer, the ballast efficacy factor is an expression of lumens per watt, for a given lighting system. For example, a ballast with a ballast factor of .88 using 60 watt of input power operating a lamp with initial lumens of 100, has a ballast efficacy factor of 1.466 (.88 x 100 / 60 = 1.466). Another ballast utilizing the same input power with a ballast factor of .82, has a ballast efficacy of 1.366. The first ballast therefore offers the greater efficacy because it has a higher ballast efficacy factor (1.466 vs. 1.366).

Lamp Flicker:
Due to the high frequency operation of most electronic ballasts, lamp flicker is virtually unnoticeable. These units reduce flicker to very low levels, making them suitable for applications where high speed video display units/cathode ray tubes are installed.

Non-PCB Capacitor:
The capacitors used in most electronic ballasts to help provide power factor correction, contain no polychlorinated biphenyls (Non-PCB), in accordance with the requirements of the Environmental Protection Agency.

Class P Thermal Protection:
Underwriters' Laboratories, Inc. requires that all ballasts used in indoor fixtures incorporate a Class P Thermal Protector. When subjected to the UL "slow rise Test, the thermal protector must disconnect the ballast from the power supply at a temperature below that at which the ballast case temperature exceeds 110 degrees Celsius. Thermal protectors are incorporated in all units. It is highly unlikely that the case temperature of the electronic ballast can reach this temperature because its electronic components do not generate a great amount of heat. Nevertheless, the thermal protector is available to function if required.